

**HEMILEIUS (ACARIDA: CRYPTOSTIGMATA: SCHELORIBATIDAE)  
FROM SOUTH AUSTRALIAN SOILS**

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*Hemileius* Berlese, 1916 is rediagnosed and compared with other genera of Scheloribatidae. Three new species; *H. (H.) biclavatus*, *H. (H.) copecius* and *H. (H.) rectus*, are grouped in the nominate subgenus. Two new species, *H. (T.) minimus* (type species) and *H. (T.) paratenuis*, are placed in a new subgenus, *Tenuileius*. These mites occurred most commonly in the litter and soil at the semi-arid, mallee-broombush and mallee-heath sites, but also at three others of the nine florally diverse South Australian sites studied. This is the first record of *Hemileius* from Australia. A key is given to distinguish the species described.

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This is a further part of an ongoing study of sarcoptiform mites in South Australian soils, sampled from nine florally diverse sites, and for which an introduction to the relevant work on the advanced oribatid mites (Planofissuridae) has been published (Lee 1987). *Hemileius* is grouped here in the Scheloribatidae Grandjean, 1933, although it is the nominate of Hemileiidae Balogh & Balogh, 1984, a family without generally accepted validity and based on an arbitrary division in the character state series between the absence and presence of pteromorphs, which is also used in a questionable delineation of *Hemileius* and *Schelorbates* (see under 'Remarks' on *Hemileius*). A new subgenus, *Tenuileius*, is established for species with a hysteronotal shield that is strongly tapered anteriorly, leaving the anterior two setae (Z1 and Z2) close to its lateral margin. The Scheloribatidae is considered further in a paper (Lee & Pajak in press) on this family, which particularly considers *Schelorbates* Berlese, 1908 and a new genus. The only other scheloribatid genus so far known from Australia is *Setobates* Balogh, 1962 (Lee & Pajak 1988).

Whilst all legs (femur-tarsus) have been illustrated in parts of this study, for *Hemileius* it has been considered sufficient to illustrate only leg II, except for one species (*H. rectus*). Measurements are in micrometres ( $\mu\text{m}$ ). The mites examined were all collected by the author and are mainly deposited in the South Australian Museum (SAMA), but also in the Field Museum of Natural History, Chicago (FMNH) and the New Zealand Arthropod Collection, D.S.I.R., Auckland (NZAC).

NOTATION

The morphological notation is as that used for Scheloribatidae by Lee & Pajak (in press), but the

following elaborations have been made to terms defining external somal ridges. A humeral tectum is distinguished from the larger pteromorph by its width being only subequal to or less than the diameter of the bothridium (base to seta z2). This is an arbitrary division of a character expressed as a continuous series of states through from no recognisable structure, an inconspicuous ridge, to a large wing-like flange or pteromorph. A ridge is considered *partial* if it extends only along part of the usual length covered. Ridges are *linear* if they form a narrow, superficial line; *costate* if they form a rib-like thickening; *laminar* if the thickening bears a flange. Ridge (or carina) *kf* (see Grandjean 1953, Fig. 2A) is here termed the *subtutorium*, a linear or costate proteropleural ridge level with acetabulum I. The subtutorium is not homologous with the tutorium since they can occur together as in *Muliercula ngoyensis* (Coetzer, 1968 Fig. 10), the tutorium running along part of a line between setae j1-z2. So far in this study no tutoria have been recognised.

SYSTEMATICS

Genus *Hemileius* Berlese

*Hemileius* Berlese, 1916, p. 322. Type species (original designation): '*Protorbates (Schelorbates) initialis* Berl.' Grandjean, 1953, p. 119. Coetzer, 1968, p. 23. C. Pérez-Iñigo, 1984, p. 170.

*Diagnosis*

Schelorbatiidae. Hysteronotum with 10 pairs of medium length or short setae (no microsetae). Pteromorph absent, humeral tectum may be present. Proteronotal setae j2-j2 separated by gap 1.25 $\times$  or less distance j2-z1. Dorsosejugal furrow

complete and curved forward between lamellae, not straight. Femurs I and II with short stalk encompassed by collar and recess in caput so that pedestal and caput nearly abut. Tibiae without proximoventral cuticular spurs. Tarsus I usually with three (*av1*, *pv1*, *v2*) proximoventral setae, rarely *v2* absent. Solenidia on tibiae III and IV taper distally (no microglobular tip). Pretarsus usually with three, rarely with two (central and anterior) claws, lateral claws without subterminal tooth and slimmer than central claw, but at least as stout as tarsal setae *d4* at halfway along their length.

#### General morphology of Australian species

General appearance bulbiform or subrectangular with somal setae, except for proteronotal files *j* and *z*, fine and short, and legs short and stout or of medium-girth. Anterior margin of hysteronotal shield not obscuring aperture of bothridium to seta *z2*. Four pairs of normal (not fissuriform) sacculate hysteronotal foramina and smooth (without tubercles or longitudinal striae) integument. Proteronotal sensory seta (*z2*) capitate, lanceolate or fusiform, not setiform. Translamellar line (between *z1-z1*) absent. Prelamella (between setae *j1-z1* or rostral margin-*z1*) costate or lineate, either may be partial. Lamella and sublamella weakly laminar, bothridium abuts onto lamella. Subtutorium straight or curved, linear or costate. Somal chaetotaxy: *2j*, *2z*, *1s*, *2I*, *6Z*, *2S*; *3I*, *III*, *3III* (rarely *2*), *3IV*; *4JZg*, *1Sg*; *2JZa*, *3Sa*; one lateral coxite seta (*III3*) may be microseta (*H. copectus*), note its absence on *H. (T.) tenuis*. Discidium rudimentary, either costate or flange height less than twice width of setal base *IV3*. Circumpedal ridge either absent or, if present, not reaching margin of opisthosternal shield. Mid-coxisternal groove present or absent. Leg chaetotaxy usually I — Tr 1, Fe 5, Ge 2 (1 *so*), Ti 4 (2 *so*), Ta 18 or 19 (2 *so*); II — Tr 1, Fe 5, Ge 2 (1 *so*), Ti 4 (1 *so*), Ta 15 (2 *so*); III — Tr 2, Fe 3, Ge 1 (1 *so*), Ti 3 (1 *so*), Ta 15; IV — Tr 1, Fe 2, Ge 2, Ti 3 (1 *so*), Ta 12. Variation on tarsus I because seta *v2* present or absent. Order of diminishing leg length — I, IV, II, III; of diminishing maximum tibial height — I, II, IV, III (or III = IV). Flanges on femurs (even femur II) small or absent. Porose areas either present or absent on femurs and trochanters III and IV, but absent on tibiae and tarsi. Trochanter IV with caput length subequal to its height, curved dorsal surface so that subglobular in profile, crown forms a distoventral crescent-shaped flange sometimes weakly bilobed.

#### Remarks

*Hemileius* is very similar to *Schelorbates*, as suggested by Grandjean (1953), the major recognised difference being the presence or absence

of a pteromorph. Despite this, Balogh & Balogh (1984) established the Hemileiidae, delineating it from the Schelorbatiidae on the basis of this character. But the recognition of a pteromorph is subjective (Norton & Palacios-Vargas 1987), although artificially defined here (see under 'Notation'). The Hemileiidae is therefore to be synonymised (Lee & Pajak in press) with Schelorbatiidae until a convincing delineating diagnosis is provided. It is also arguable that *Hemileius* should be regarded as a junior synonym of *Schelorbates*, because there is a strong similarity between *Hemileius rectus* sp. nov. and a small species of *Schelorbates* from the mallee-heath site (see Lee & Pajak in press) and *Hemileius initialis* (type species) is similar to some larger *Schelorbates* species.

In relation to other members of the Schelorbatiidae, *Hemileius* is also superficially very similar to other members of the Hemileiinae Balogh & Balogh, 1984, as well as five genera (*Cryptozetes* Hammer, 1962; *Domitorina* Grandjean, 1951; *Metaleius* Travé, 1960; *Paraleius* Travé, 1960 and *Siculobata* Grandjean, 1953) overlooked by Balogh & Balogh (1984) in their review of the Oripodoidea (as 'Oribatuloidea'). Members of these five genera are adequately described, but their relationships are uncertain. *Cryptozetes*, *Domitorina* and *Siculobata* are principally epiphytic or saxicolous mites and their relationships are discussed by Norton & Palacios-Vargas (1987) in terms of specialisations, often regressive synapomorphies, for being epiphytic and derived from character states of edaphic genera such as *Hemileius*. It should be noted that whilst pteromorphs, pleural recesses delineated by circumpedal ridges or processes, and angular leg segment shapes are derived in the Oripodoidea, the loss of hysteronotal setae by *Hemileius* suggests that its lack of such character states may represent regressive synapomorphies, possibly for living in deeper soil layers, and sometimes it may also be saxicolous or epiphytic. The five species described here illustrate the problems of defining schelorbatiid genera and diagnosing a genus such as *Hemileius*. They are smaller than the established species and also differ in lacking porose areas on the tibiae and tarsi. The species most superficially similar to the type species, *H. biclavulus*, differs in having only two pretarsal claws and it also lacks a proximoventral seta on tarsus I as for *Cryptozetes*, *Domitorina* and *Siculobata*. Another species, *H. rectus*, shows similarities to *Schelorbates*, whilst *H. copectus* is intermediate in form. Two species, *H. minimus* and *H. paratenuis*, are similar to the previously established *H. tenuis* Aoki, 1982, may represent a lineage adapted for deeper soil layers, and are referred to a new subgenus, *Tenuileius*. If there is

more confidence in the similarity between its members not reflecting convergence, then it might be better regarded as a genus. The formal diagnosis of *Hemileius* used by Coetzer (1968), that implied by the couplets in the keys of Balogh & Balogh (1984), as well as that provided here, may not indicate relationships.

To establish the number of known species in *Hemileius* is difficult. Initially the genus (as a subgenus of *Oribatula*) included eight species, of which one had a subspecies (as a variety), and for which the descriptions had limited value. Three of these species became the types of either *Dometorina*, *Siculobata* or *Liebstadia*, whilst the other four species have rarely been referred to since. Coetzer (1968) excluded four species from *Hemileius*, that had previously been in *Liebstadia* (multiporose rather than sacculate foramina) or *Schelorbates* (pteromorph present). Of the seven species newly combined with *Hemileius* by Coetzer (1968), C. Pérez-Iñigo (1984) excluded one and suggested that the other six, as well as the four rarely referred to species grouped in *Hemileius* when it was established, should probably also be excluded. The 15 species grouped here in *Hemileius* are listed under the two subgenera.

KEY TO SOUTH AUSTRALIAN  
*HEMILEIUS* SPECIES (ADULTS)

- 1 — Setal distance  $\alpha 2$ -Z1  $0.8\times$  or less distance  $\alpha 2$ -j2. Hysteronotal humeral margin convex with tectum. If pedotectum II extends laterally further than I, then humeral tectum extends further still. . . . . *Hemileius (Hemileius)* Berlese, 2.
  - Setal distance  $\alpha 2$ -Z1 subequal to distance  $\alpha 2$ -j2. Hysteronotal humeral margin concave, without humeral tectum. Pedotectum extends laterally further than I. . . . . *Hemileius (Tenuileius)* subgen. nov., 4.
- 2 — Interlamellar seta (j2) medium-length, able to reach  $\alpha 1$ . Setal distance II-I about  $2\times$  distance III-III. Short midsternal apodeme level with setae III and III. . . . . *H. (Hemileius) copectus* sp. nov.
  - Interlamellar seta (j2) long, able to reach j1. Setal distance II-I subequal to distance III-III. No midsternal apodeme. . . . . 3
- 3 — Pretarsi with two claws. Humeral tectum width about  $0.3\times$  diameter of bothridium (base to seta  $\alpha 2$ ). Hysterosoma bulbiform. Pedotectum II not extended laterally as far as I. . . . . *H. (Hemileius) biclavulus* sp. nov.
  - Pretarsi with three claws. Humeral tectum width subequal to diameter of bothridium (base to seta  $\alpha 2$ ). Hysterosoma parallel-sided.

Pedotectum II extends laterally further than I . . . . . *H. (Hemileius) rectus* sp. nov.

- 4 — Sensory seta  $\alpha 2$  caput subglobose. Subtutorium extends forward to near seta  $\alpha 1$ . Hysteronotal shield very narrow, seta Z2 as close to margin as diameter of its base. Gap between genital orifice and anterior sternal margin  $1.5\times$  or more distance between genital and anal orifice. . . . . *H. (Tenuileius) minimus* sp. nov.
  - Sensory seta  $\alpha 2$  caput fusiform. Subtutorium not extended forward to near seta  $\alpha 1$ . Hysteronotal shield narrow, seta Z2 more than  $0.5\times$  its length away from margin. Gap between genital orifice and anterior sternal margin less than  $1.5\times$  distance between genital and anal orifice. . . . . *H. (Tenuileius) paratenus* sp. nov.

Subgenus **Hemileius (Hemileius)** Berlese

*Diagnosis*

*Hemileius*. Hysteronotal seta Z1 near to anterior margin of hysteronotal shield (distance  $\alpha 2$ -Z1  $0.8\times$  or less distance  $\alpha 2$ -j2). Hysteronotal shield wide with convex humeral tectum dorsally obscuring pleural striated cuticle and leaving seta Z2 more than its length away from margin. Pedotectum II usually not extending laterally further than I; if it does, then humeral tectum extends further still.

*General morphology of Australian species*

Colour shiny brown or yellowish-brown. Smaller than established species (247-447 compared to 450-710). Legs short (mean femur-tarsus length: 36-40% of somal length) and tibiae medium-girth to stout (mean maximum height: 38-49% of mean length). Humeral tectum and limbus widths between  $0.3\times$  and subequal to diameter of bothridium, but not correlated (e.g. *H. biclavulus* with inconspicuous humeral tectum and broad limbus), limbus encompassing entire hysteronotum behind humeral tectum. Sacculate foramina with slit-shaped or round pores.

*Distribution*

Although some species from the Southern Hemisphere have been grouped in *Hemileius*, previously established species currently in this genus all appear to be known only from the Northern Hemisphere. Records and species numbers are greatest from southern parts of northern temperate regions, either around the Mediterranean and Canary Islands (Pm) or in the United States of America (Nr, Na) and Hawaii (Ap). Records from further north (Pe, Nn) are limited to *Hemileius initialis* in Europe and to *H. quadripilis* and an unidentified species in Canada (Marshall, Reeves & Norton 1987).



The three new species of *Hemileius* (*Hemileius*) from South Australia appear to be the only Southern Hemisphere records. Two species occur in large enough numbers at relatively dry semi-arid, mallee-broombush and mallee-heath sites to support their ecological categorisation as hemiedaphic or, in the case of the smaller species, as possibly being euedaphic. The other species, *Hemileius copectus*, is mainly found (32 adults) at the semi-arid site, but is also represented by a single specimen at both sclerophyll forest and pine forest sites, suggesting that an edaphic species at a drier site may be saxicolous or epiphytic at the moister sites and so poorly represented in soil and litter samples.

#### Remarks

*Hemileius* (*Hemileius*), the nominate subgenus, includes a heterogeneous majority of species in the genus. It ranges in form from the type, which is somewhat like *H. biclavulus* and has similarities to the epiphytic *Domatorina* for example, to *H. rectus* with similarities to some *Scheloribatex*.

The following 12 species are grouped in *Hemileius* (*Hemileius*): *H. (H.) biclavulus* sp. nov.; *H. (H.) comatus* Berlese, 1920; *H. (H.) copectus* sp. nov.; *H. (H.) elongatus* E. Pérez-Iñigo, 1978; *H. (H.) gressitti* Balogh & Balogh, 1983; *H. (H.) haydeni* (Higgins & Woolley, 1975); *H. (H.) hierrensis* C. Pérez-Iñigo, 1984; *H. (H.) initialis* (Berlese, 1908), type species; *H. (H.) nicki* Deamark & Woodring, 1965; *H. (H.) quadripilis* Fitch, 1856 (syn. *pallida* Ewing, 1909); *H. (H.) rectus* sp. nov.; *H. (H.) robustus* C. Pérez-Iñigo, 1969.

The generic placement of *H. (H.) quadripilis* is problematic (see Marshall, Reeves & Norton 1987), but its synonymy with *H. (H.) pallida* Ewing, 1909 is accepted, although *H. (H.) pallida* Ewing; Hamner, 1952 from Canada (Nn) may not be conspecific with it, having substantially shorter hysteronotal setae.

#### *Hemileius* (*Hemileius*) *biclavulus* sp. nov.

Figs 1, 2 and 8

#### Female

Dorsal profile usually bulbiform, sometimes more parallel-sided than illustrated (Fig. 1). Idiosomal length, 404 (25, 380–447). Leg lengths (femur-tarsus for idiosomal length 411): I — 198, II — 161, III — 136, IV — 163. Tibial maximum heights (for 411): I — 23, II — 18, III — 15, IV — 15.

Proteronotum with incomplete prelamella extending from seta *j*1 only halfway towards *z*1. Lamella and sublamella costate, sublamella less robust, runs close to lamella along anterior half, bothridium (base *z*2) closer to lamella. Subtutorium

linear and straight, with alveolate sculpturing posterior and ventral to it. Setae *j*1, *j*2, *z*1 inconspicuously ciliate, interlamellar (*j*2) and lamellar (*z*1) setae long, *j*2 reaching to level of *j*1, and *z*1 reaching beyond rostral apex. Sensory seta (*z*2) long, reaching *z*1; exposed stalk slightly longer than caput (appears shorter in Fig. 1 because sloping dorsalwards); caput fusiform, three files of cilia, maximum of seven cilia in any file, parallel-sided when viewed dorsally (Fig. 1), uniconvex viewed laterally. Seta *s*2 length about twice diameter of bothridial aperture.

Hysteronotal setae subequal in length, but *J*6, *Z*6, *S*6 slightly longer. Humeral tectum small but limbus substantial, width about  $\times 0.3$  and subequal to diameter of bothridium respectively. Two pairs of unnamed pores (usually anterior pair between seta *Z*2–foramen *F*3, posterior pair between seta *S*5–midline; rarely anterior pair between foramen *F*3–midline or third pair between *Z*4–midline). Slit-like pore *hf*3 short, approximately transverse; *hf*4 and *hf*5 parallel to lateral margin, visible ventrally (not illustrated in Fig. 2, too near margin), *hf*6 oblique, adaxial end posterior. Sacculate foramina with slit-shaped pores.

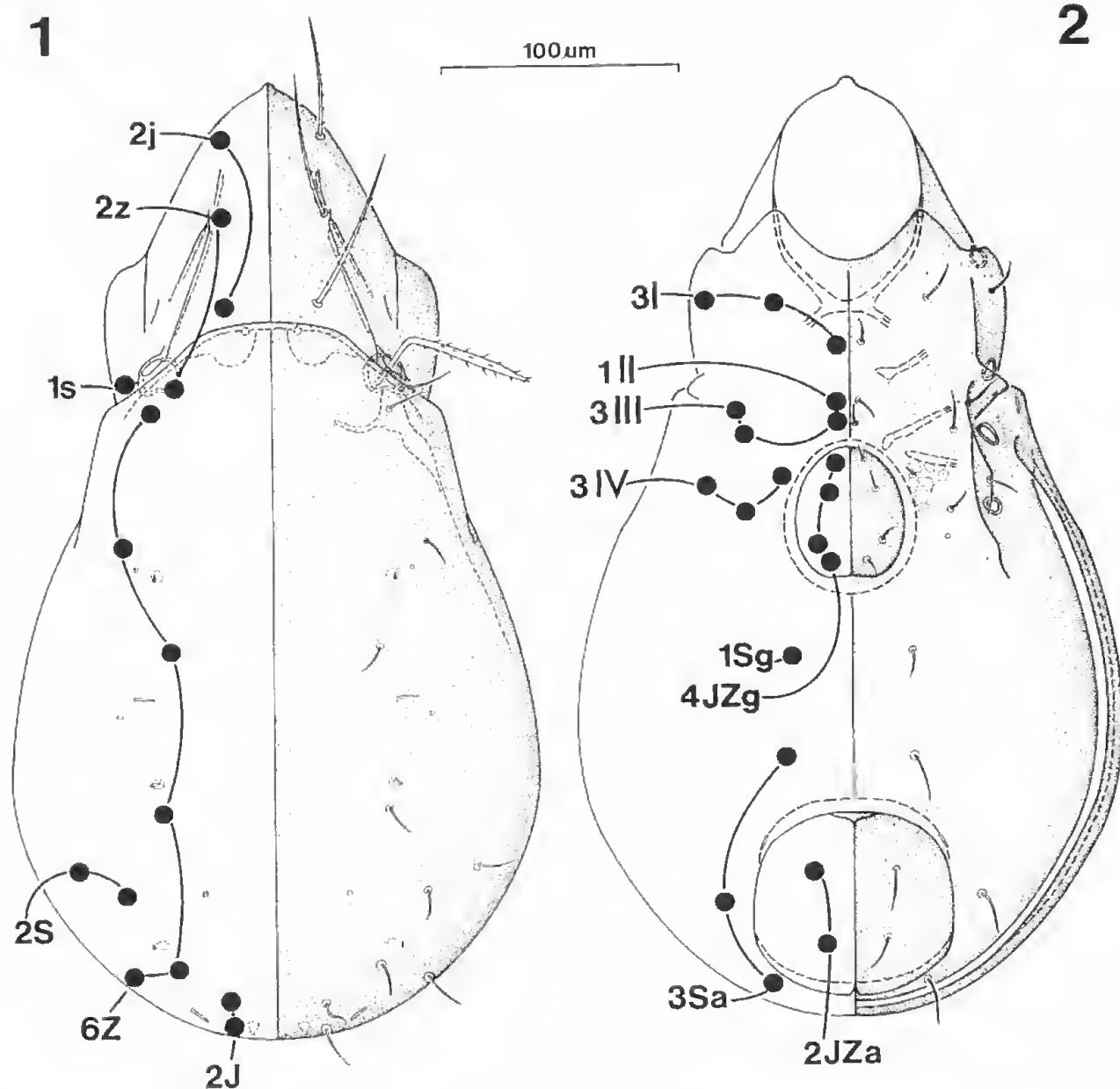
Podosternum with medium gap (about  $0.66 \times$  setal distance *II–III*) between apodemes I. Adaxial end of apodeme III base latitudinally level with genital seta *JZ*1 and longitudinally level with coxite seta *IV*1. Custodial ridge present. Discidium forms shallow flap (depth about twice diameter of setal base *IV*3). Circumpedal ridge reaching forward to merge with discoidal ridge and backward so that half of its length lies posterior to aperture to acetabular cavity IV. Alveolate sculpturing along midcoxite region (Fig. 2, illustrated only on coxite IV). No midsternal apodeme. Lateral coxite setae longer than those around genital shield.

Opisthosternum with genital setae less than half length of anal setae. Eggs subcylindrical,  $189 \times 85$  (2 eggs, 47% of somal length 401), rugose exochorion. Number of eggs in female (number of females) as follows: none (12), one (3), two (12), three (9), four (4).

Legs short (mean femur-tarsus length: 40% of soma). Dorsal porose area on all femurs and trochanters III and IV. Rugae posteriorly on femurs III and IV. Shallow ventral flanges on keels of femurs II, III and IV. Solenidium *sol* on tarsus I subequal in diameter to base of seta *d*3, and reaching setae *d*4. Only five ventral setae on tarsus I, proximoventral seta *v*2 absent, proximal three with 8 to 10 cilia (longest cilium longer than setal base diameter). Pretarsi with two claws (anterior slim and central stout claw).

#### Male

As female, except proteronotal setae in files *j* and



FIGURES 1 AND 2. *Hemileius (Hemileius) biclavulus* sp. nov., female soma. 1, notum; 2, idiosternum.

z may be slightly longer. Soma smaller, idiosomal length 367 (mallee-heath, 25, 339-373) and 362 (mallee-broombush, 1).

#### Material examined

Holotype: ♀ (N198887), sand, litter, under banksia shrubs (*Banksia ornata*), Tamboore Homestead (35°57'S, 140°29'E), 4.viii.1974.

Paratypes: 27 ♀♀ (N198888-N1988114), 72 ♂♂ (N1988115-N1988186), same data as holotype; 2 ♀♀, 2 ♂♂ — FMNH; 2 ♀♀, 2 ♂♂ — NZAC.

Undesignated: 120 ♀♀, 309 ♂♂, same data as holotype. Single ♂ (N1988187), sand, litter, sparse moss, under ridge-fruited mallee (*Eucalyptus incrassata*) amongst broombush shrubs (*Melaleuca uncinata*), Ferries-McDonald Reserve (35°15'S, 139°09'E), 20.vi.1974.

#### Distribution

Australia (Aa). South Australia. Mallee-broombush, open scrubland (Ferries-McDonald Reserve), Murray-Darling basin, 1 ♂/1 ♀ of 8 × 25 cm<sup>2</sup>. Mallee-heath, tall open shrubland (Tamboore Homestead, near Mt Rescue Conservation Park), Murray-Darling basin, 148 ♀♀, 381 ♂♂/8 of 8 × 25 cm<sup>2</sup>.

#### Remarks

*H. biclavulus* is the largest South Australian species of *Hemileius* with similar facies to the slightly bigger type species, *H. initialis*. On the other hand, *H. biclavulus* is unique in the subgenus in having only two pretarsal claws and five ventral setae on tarsus I (a reduced ventral setation on

tarsus I is also recorded for the epiphytic *Cryptozetes*, *Domitorina* and *Siculobata*. Although given a minor weighting here, these two characters have been used to diagnose oripodoid genera.

*Hemileius (Hemileius) copectus* sp. nov.

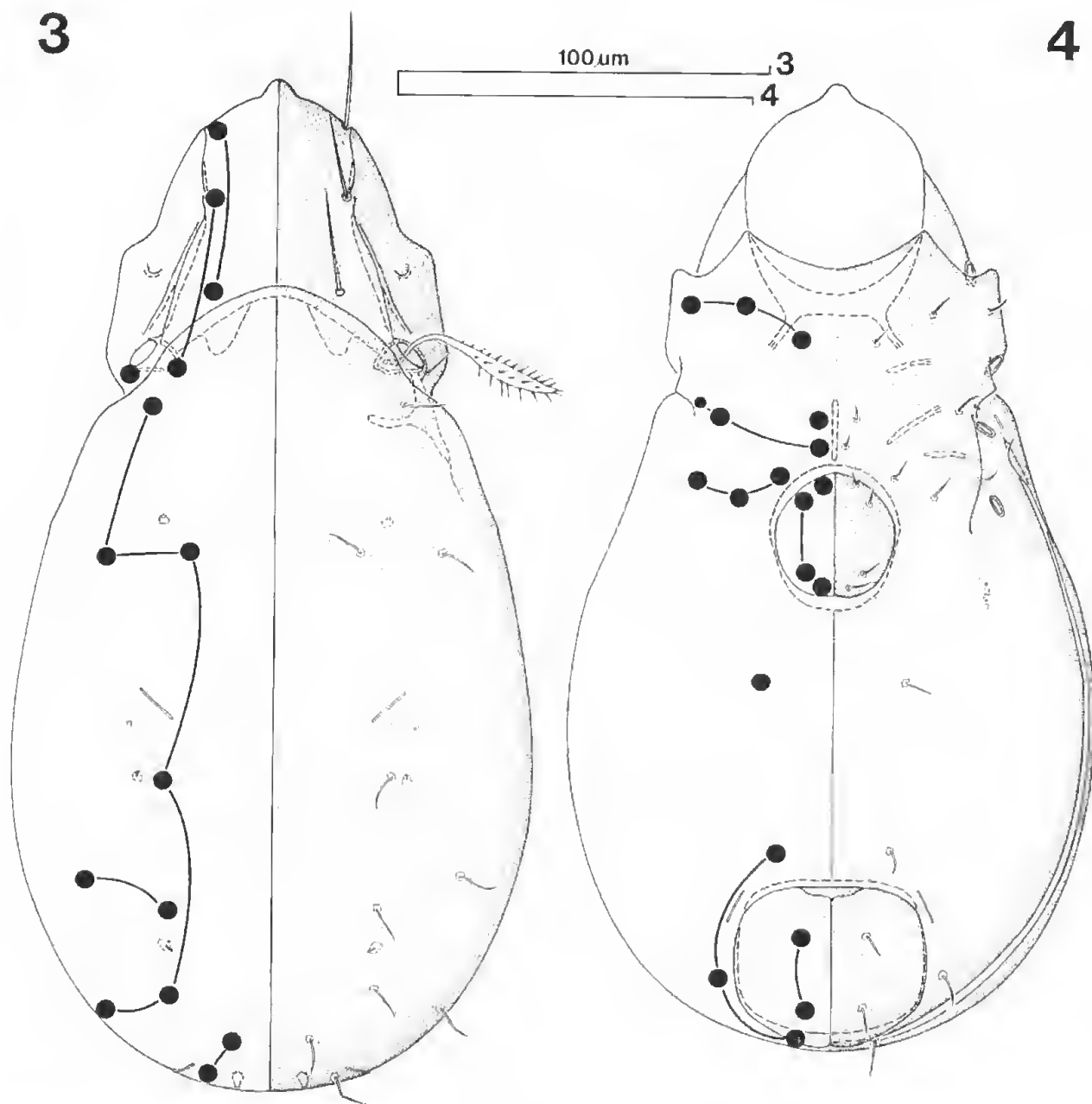
Figs 3, 4 and 9

*Female*

Dorsal profile ovoid. Idiosomal length, 278 (semi-arid shrubland, 10, 262-288) and 270 (sclerophyll forest, 1). Leg lengths (femur-tarsus for idiosomal length 276, semi-arid shrubland): I — 123, II — 108,

III — 95, IV — 111. Tibial maximum heights (for 276): I — 15, II — 13, III — 12, IV — 12.

Proteronotum with complete prelamella (seta *j1-z1*-rostral margin), costate near *j1*, rest linear. Lamella laminar, sublamella costate, runs close to lamella along anterior half (may appear more robust from some angles because more refractile), bothridium (base of seta *z2*) closer to lamella. Subtutorium semicircular, linear. Setae *j1*, *j2*, *z1* inconspicuously ciliate, interlamellar (*j2*) and lamellar (*z1*) setae medium-length; *j2* reaching *z1*, *z1* reaching *j1*. Sensory seta (*z2*) long, reaching *z1*; exposed stalk slightly shorter than caput (appears even shorter in Fig. 4 because sloping dorsalwards); caput fusiform, three files of cilia, anterior file on



FIGURES 3 AND 4. *Hemileius (Hemileius) copectus* sp. nov., female soma. 3, notum; 4, idiosternum.

straight margin with 14–16 cilia along caput and stalk, other files with 6–8 cilia confined to caput. Seta *s2* length subequal to diameter of bothridial aperture.

Hysteronotal setae subequal in length, but *J6*, *Z6*, *S6* slightly larger. Humeral tectum and limbus small, width of both  $\times 0.3$  diameter of bothridium. Unnamed pores not located. Slit-like pore *hf3* oblique, adaxial end posterior, *hf4* and *hf5* parallel to lateral margin, visible ventrally (not illustrated in Fig. 4, too near margin), *hf6* oblique, adaxial end anterior. Sacculate foramen *F3* with round pore, whilst *F4*, *F5*, *F6* with slit-shaped pores.

Podosternum with wide gap (subequal to *I1–I11*) between apodemes 1. Adaxial end of apodeme *111* base latitudinally level with coxite seta *III1* and on longitudinal line closer to coxite seta *IV2* than *IV1*. Midsternal apodeme between setal pairs *III1* and *III11*. No custodial ridge. Discidial ridge without discidium. No circumpedal ridge. Pedotectum 11 short, not extending as far laterally as pedotectum 1. No midcoxite sculpturing or midsternal apodeme. Coxite setae all short, *III1* and *III11* particularly short, seta *III3* inconspicuous microseta.

Opisthosternum with genital setae more than half length of anal setae, but adanal setae *Sa2*, *Sa3* longer. Eggs subcylindrical,  $157 \times 82$  (1 egg, 55% of somal length 285), granulate exochorion. Number of eggs in female (number of females) as follows: none (9), one (3).

Legs short (mean femur–tarsus length: 40% of soma). Indistinct porose area on femurs and trochanters *III* and *IV*. Indistinct rugae on femurs *III* and *IV*. No ventral flanges on keels (not discernible from lateral aspect) of femurs *II*, *III*, *IV*. Solenidium *sol1* on tarsus 1 subequal in diameter to base of setae *d3*, and reaching setae *d4*. Six ventral setae on tarsus 1, proximoventral seta *v2* present, proximal four with three or four cilia (longest cilium longer than setal base diameter). Pretarsi with three claws (central stout claw, lateral slim claws).

#### Male

As female, except soma smaller, idiosomal length, 259 (semi-arid shrubland, 18, 252–271) and 262 (pine forest, 1).

#### Material examined

Holotype: ♀ (N1988188); soil, litter, moss and other low growth plants under bladder saltbush (*Atriplex vesicaria*) amongst sparse false sandalwood (*Myoporum platycarpum*), Koonamore Vegetation Reserve (32°07'S, 139°21'E), 27.vi.1974.

Paratypes: 9 ♀♀ (N1988189–N1988197), 18 ♂♂ (N1988198–N1988215), same data as holotype.

Undesignated: 2 ♀♀ and 2 ♂♂ lost, same data as holotype. Single ♀ (N1988216), soil, litter, sparse

moss, under sclerophyllous shrubs amongst messmate stringybark (*Eucalyptus obliqua*), nr summit of Mt Lofty, Cleland Conservation Park, 34°59'S, 138°45'E, 9.v.1974. Single ♂ (N1988217), soil, litter, under *Pinus pinea*, Kuitpo Forest Reserve (35°12'S, 138°41'E), 22.v.1974.

#### Distribution

Australia (Aa), South Australia. Semi-arid low shrubland (Koonamore Vegetation Reserve), Lake Eyre Basin, 12 ♀♀, 20 ♂♂/6 of  $8 \times 25$  cm<sup>2</sup>. Sclerophyll forest (Mt Lofty, Cleland Conservation Park), South gulfs, ♀/1 of  $8 \times 25$  cm<sup>2</sup>. Cultivated pine forest (Kuitpo Forest Reserve), South gulfs, ♂/1 of  $8 \times 25$  cm<sup>2</sup>.

#### Remarks

*H. copectus* is distinguishable from non-Australian species in the nominate subgenus by its small size and only medium-size proteronotal setae *z1* and *j2*. It is similarly distinguishable from *H. biclavulus*, whilst *H. rectus*, which is of a similar size, has long proteronotal setae and a more substantial humeral tectum. Ventrally, coxite seta *III3* is reduced to a microseta, drawn slightly larger in illustration (Fig. 4) so that it is recognisable, and there is a short midventral apodeme anterior to the genital shield, both unique character states for the genus.

#### *Hemileius (Hemileius) rectus* sp. nov.

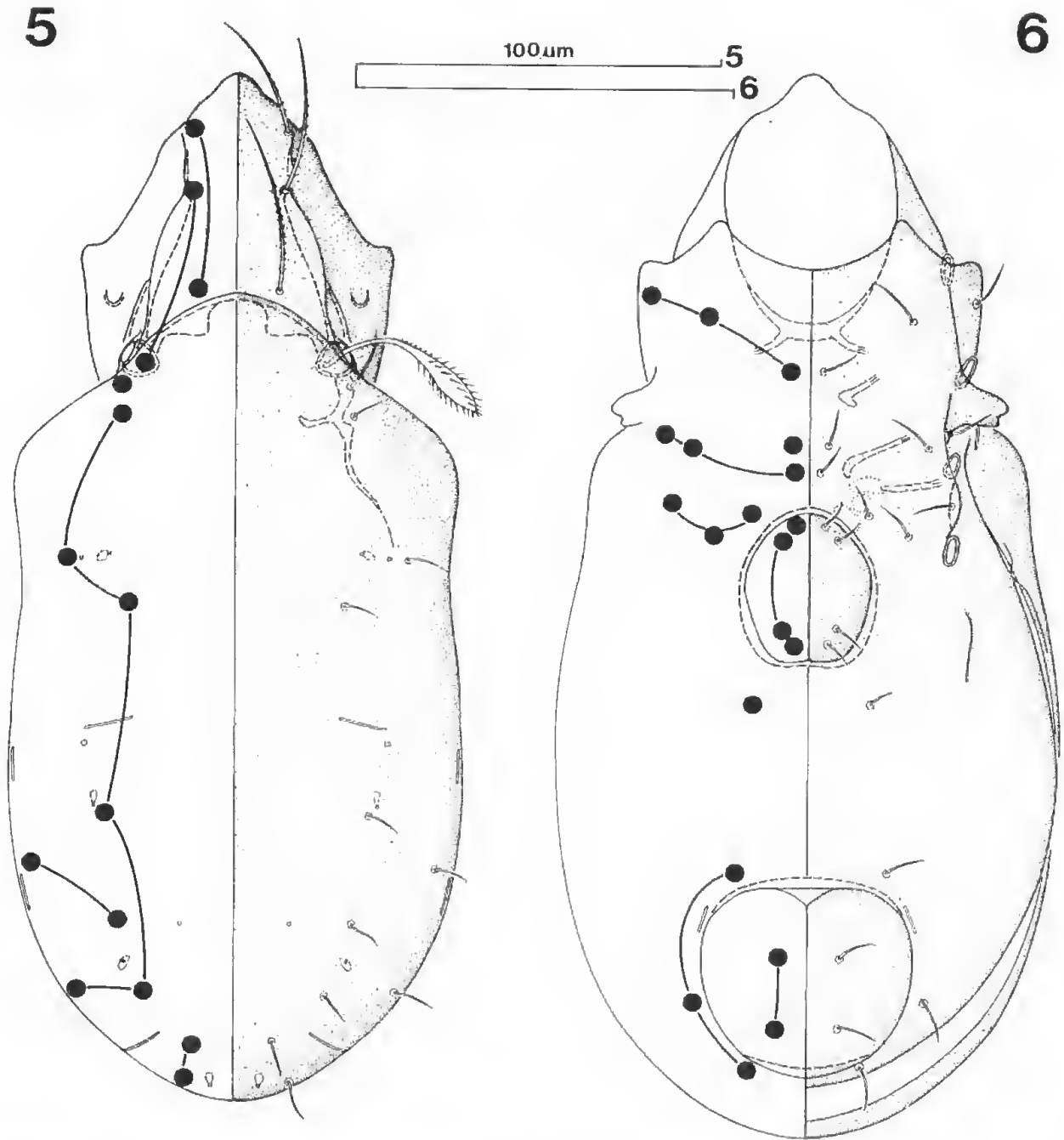
Figs 5–7

#### Female

Dorsal hysteronotal profile subrectangular, partly due to humeral tecta. Idiosomal length, 280 (25, 260–300). Leg lengths (femur–tarsus for idiosomal length 293): *I* — 121, *II* — 105, *III* — 85, *IV* — 113. Tibial maximum heights (for 293): *I* — 18, *II* — 15, *III* — 13, *IV* — 14.

Proteronotum with complete prelamella (seta *j1–z1*), costate near *j1*, rest linear. Lamella mainly laminar, costate near *z2*. Sublamella costate, runs close to lamella along anterior half, bothridium (base seta *z2*) closer to lamella. Setae *j1*, *j2*, *z1* inconspicuously ciliate, interlamellar (*j2*) and lamellar (*z1*) setae long; *j2* reaching level of *j1*, *z1* reaching beyond rostral apex. Sensory seta (*z2*) medium-length, reaching beyond *j2*; exposed stalk shorter than caput; caput fusiform, three files of cilia, anterior file with 16–18 cilia along caput and stalk, medium file with 8–9 cilia and posterior file with 11–13 cilia confined to caput. Seta *s2* length about  $1.5 \times$  diameter of bothridial aperture.

Hysteronotal setae subequal in length, but *J6* and *Z6* slightly longer. Humeral tectum conspicuous, width about  $0.25 \times$  distance *Z1–Z2*; limbus small,



FIGURES 5 AND 6. *Hemileius (Hemileius) rectus* sp. nov., female soma. 5, notum; 6, idiosternum.

width about  $0.1 \times$  distance Z1-Z2. Unnamed circular pores present between and near setae Z2 and S4. Slit-like pore *hf3* oblique, with adaxial end anterior, sometimes transverse, rarely adaxial end posterior (one side only), *hf4* and *hf5* visible dorsally (Fig. 5), *hf6* oblique with adaxial end anterior. Sacculate foramina with round pores.

Podosternum with medium gap (about two thirds II-III) between apodemes I. Adaxial end of apodeme III base latitudinally level with point anterior to genital shield and longitudinally level with point closer to coxite seta IV1 than IV2.

Custodial ridge present. Discidium forms a shallow flap (depth about twice diameter of setal base IV3). Short straight circumpedal ridge separate and well behind other subpodal ridges. Weak alveolate sculpturing along mid-coxite region (Fig. 6, illustrated only on coxite IV). No midsternal apodeme. Pedotectum II robust, long, extending further laterally than pedotectum I. Lateral coxite setae longer than those around genital shield.

Opisthosternum with genital setae about two-thirds length of anal setae. One female with 6JZg on one side (extra seta halfway between JZg2-JZg3).



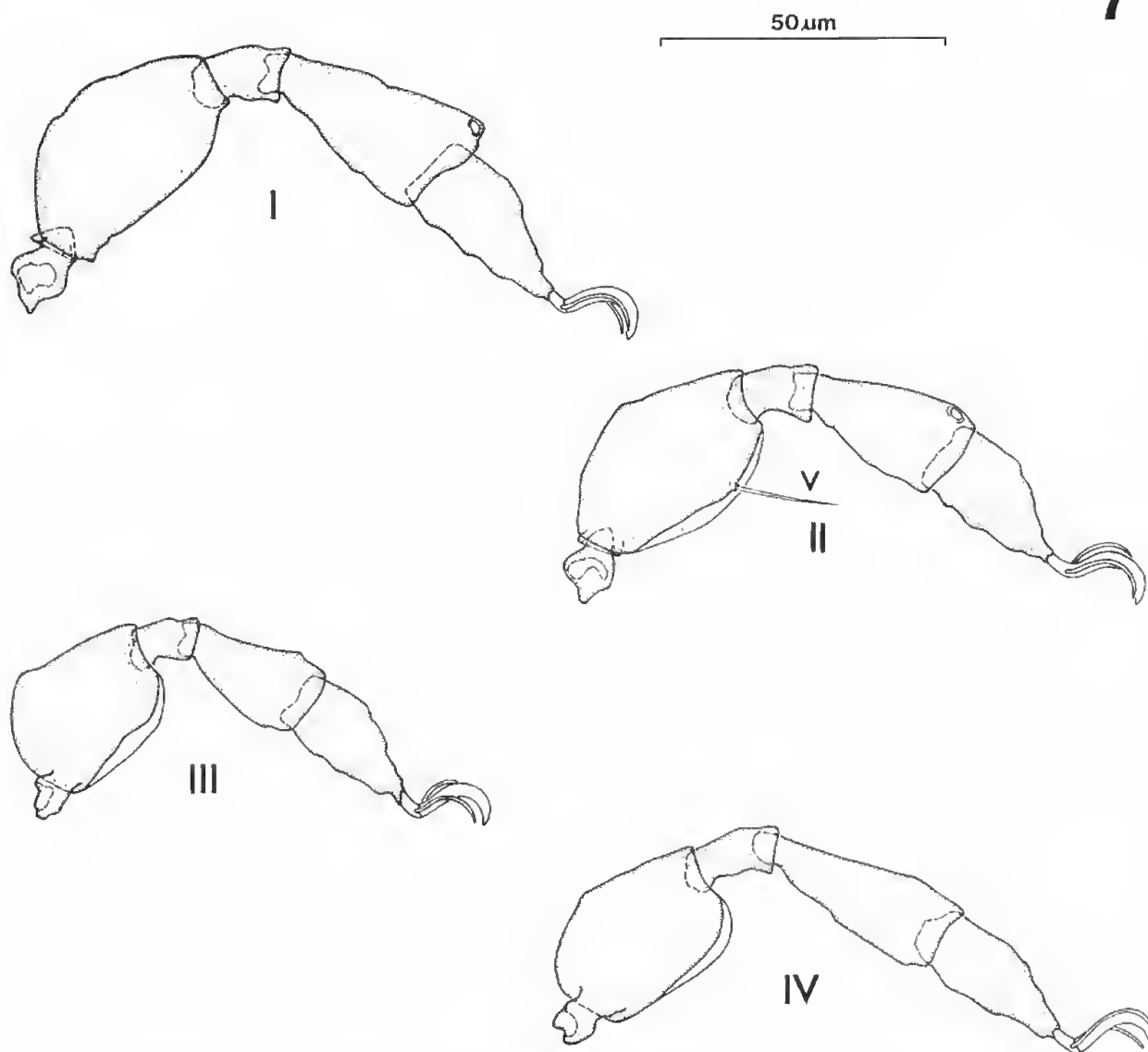


FIGURE 7. *Hemileius (Hemileius) rectus* sp. nov., posterior aspect to femur-pretarsus of right legs showing only one seta.

Eggs oval,  $139 \times 80$  (1 egg, 50% of somal length 278), granular exochorion. Number of eggs in female (number of females) as follows: none (30), one (36), two (5).

Legs short (mean femur-tarsus length: 36% of soma). Porose areas on femurs and trochanters III and IV. Indistinct or no rugae on femurs I and II, distinct rugae on femurs III and IV. Shallow ventral flanges on femurs II, III, IV. Solenidium *sol* on tarsus I subequal in diameter to base of seta *d3* and reaching setae *d4*. Ventral setae on tarsus I with six or seven cilia (longest cilium subequal in length to seta base diameter) along two thirds of length. Six ventral setae on tarsus I, proximoventral seta *v2* present, all of them with 8 or 10 cilia, longest subequal to setal base in diameter. Pretarsi with three claws (central stout claw, lateral slim claws).

#### Male

As female, except smaller soma, idiosomal length 247 (25, 226-265).

#### Material examined

Holotype: ♀ (N1988218); soil, litter and sparse moss under ridge-fruited mallee (*Eucalyptus incrassata*) clumps amongst broombush shrubs (*Melaleuca uncinata*), Ferrics-McDonald Conservation Park (35°15'S, 139°09'E), 20.vi.1974.

Paratypes: 66 ♀♀ (N1988219-N1988277 and N1989148-N1989154), 40 ♂♂ (N1988278-N1988311 and N1989155-N1989160), same data as holotype; 2 ♀♀, 2 ♂♂ — FMNH; 2 ♀♀, 2 ♂♂ — NZAC.

#### Distribution

Australia (Aa). South Australia. Mallee-

broombush, open scrubland (Ferries-McDonald Reserve), Murray-Darling basin, 71 ♀ ♀, 44 ♂ ♂ / 7 of 8 × 25 cm<sup>2</sup>.

*Remarks*

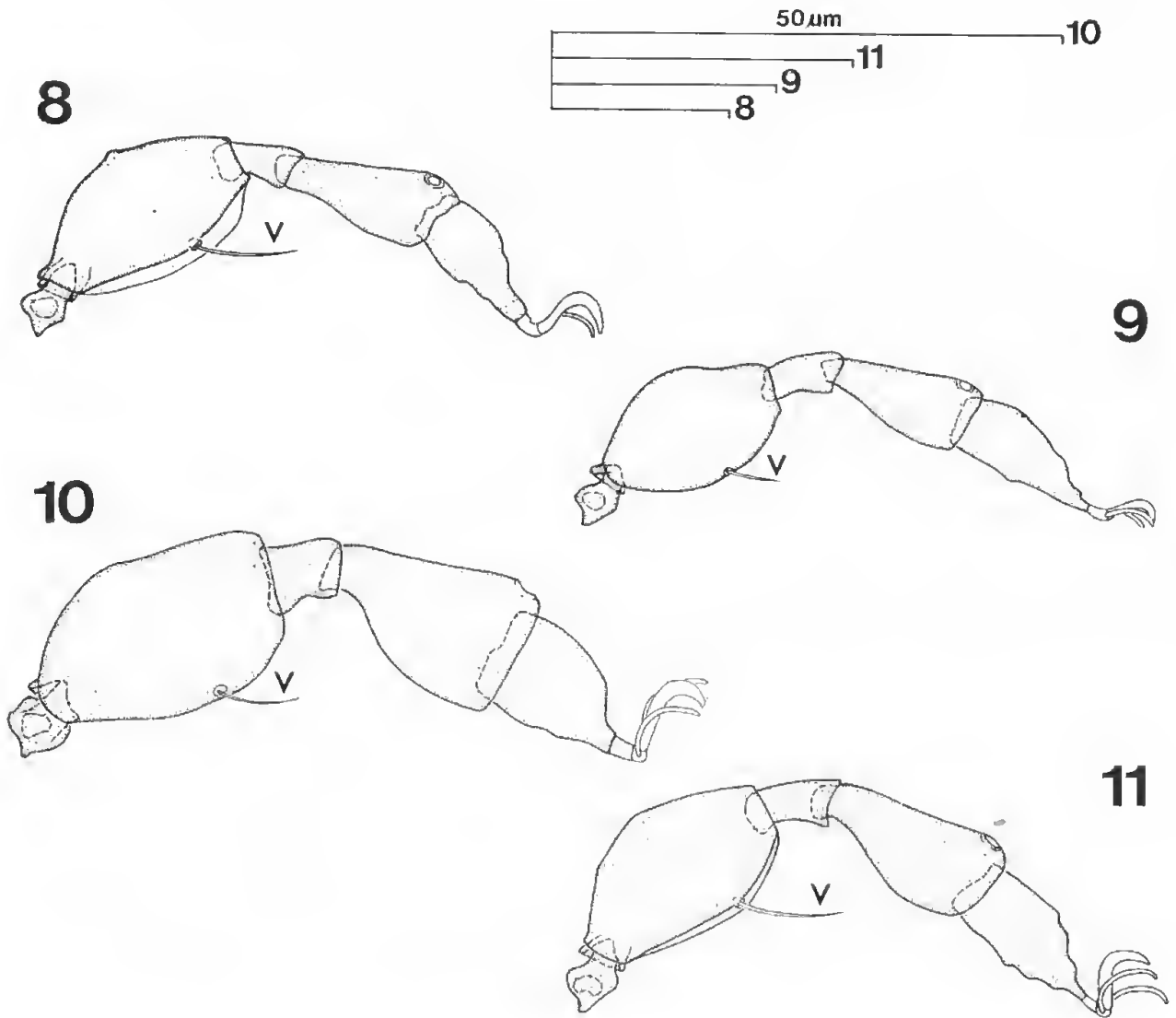
*H. rectus* is distinguishable from non-Australian species in the nominate subgenus by its smaller size. It has the largest humeral tectum for the genus, which, with the parallel-sided hysteronotum and long interlamellar and lamellar setae, makes it appear similar to some small species of *Scheloribates*. But the humeral tectum in lateral view is substantially smaller than the pteromorphs of *Scheloribates* as is the ventral flange on femur II, although the similarities may reflect a close relationship.

Subgenus *Hemileius (Tenuileius)* subgen. nov.

Type species: *Hemileius (Tenuileius) minimus* sp. nov.

*Diagnosis*

*Hemileius*. Hysteronotal seta Z1 distant from anterior margin of hysteronotal shield (distance z2-Z1 subequal to z2-j2). Hysteronotal shield narrow anteriorly with humeral margin strongly tapered, linear and without tectum, so that seta Z2 less than its length from margin. Striated cuticle that separates hysteronotum from ventral shields clearly visible from above, reaching as far forward as seta z2. Pedotectum II extends laterally further than I.



FIGURES 8-11. Right legs II, posterior aspect to femur-pretarsus. 8, *Hemileius (Hemleius) biclavulus* sp. nov.; 9, *Hemileius (Hemileius) copectus* sp. nov.; 10, *Hemileius (Tenuileius) minimus* sp. nov.; 11, *Hemileius (Tenuileius) paratenuis* sp. nov.

*General morphology of Australian species*

Colour, shiny yellowish-brown. Smallest species in genus (175–298). Legs short (mean femur-tarsus length: 37–38% of somal length) and tibiae very stout (mean maximum height: 52–59% of mean length). Limbus restricted to margin of hysteronotal shield behind slit-like pore *hf4*, narrow, width about 0.3 × diameter of bothridium. Sacculate foramina with round pores.

*Distribution*

Currently *Tenuileius* appears to be confined to regions around the Pacific, species being recorded from Australia (Aa), Japan (Pc) and possibly Hawaii (Ap).

*Remarks*

*Tenuileius* includes two Australian species in which the hysteronotal shield is strongly tapered anteriorly, with no marginal thickening, and leaving the pleural striated cuticle, which extends unusually well forward, visible from above. Associated with this, seta *Z1* is transposed backwards from the anterior margin of the hysteronotal shield and sometimes towards the mid-line. The anterior narrowing of the hysteronotal shield may have been overlooked in the past since it lies above a region including the highly refractile structures around the sejugal division. Therefore, *H. tenuis* Aoki, 1982 is included in the subgenus on the basis of other similarities to *H. paratenius*. Also, it is noted that whilst *H. gressitti* Balogh & Balogh, 1983 is left in the nominate subgenus, it should be regarded as a potential candidate for inclusion in *Tenuileius* that awaits further examination. As pointed out in the 'Remarks' on the genus, members of this subgenus may be adapted to live in the deeper soil layers. If the adaptations are apomorphic, *Tenuileius* might be better reranked to be a genus. The following three species are grouped in *Hemileius (Tenuileius)*: *H. (T.) minimus* sp. nov., type-species; *H. (T.) paratenius* sp. nov.; *H. (T.) tenuis* Aoki, 1982.

*Hemileius (Tenuileius) minimus* sp. nov.

Figs 10, 12 and 13

*Female*

Dorsal hysteronotal profile slim, oval. Idiosomal length, 190 (6, 185–200). Leg lengths (femur-tarsus for idiosomal length 187): I — 82, II — 67, III — 59, IV — 69. Tibial maximum heights (for 187): I — 15, II — 13, III — 12, IV — 12.

Proteronotum with complete prelamella (seta *j1*—rostral margin), costate near *j1*, rest linear. Lamella mainly laminar, linear near *z2*. Sublamella costate, runs close to lamella along anterior half, bothridium (base of seta *z2*) close to lamella.

Subtutorium present, costate, dorsally extending to near seta *z1*. Setae *j1*, *j2*, *z1* inconspicuously ciliate, interlamellar (*j2*) and lamellar (*z1*) setae medium-length, both only reaching level of *z1* and *j1* respectively. Sensory seta short, not reaching *j2*; exposed stalk shorter than caput, caput subglobose (laterally compressed), two ranks of cilia in six or seven files. Seta *s2* length about 2 × diameter of bothridial aperture.

Hysteronotal setae short (but nearly as long as *j2*), subequal in length, peripheral (*J6*, *Z3*, *S6*, *Z6*) setae slightly longer. Slit-like pore *hf3* nearly transverse, adaxial end anterior; *hf4* and *hf5* near lateral margin, visible dorsally, *hf6* partially visible dorsally.

Podosternum with moderately wide gap (slightly less than *II-III*) between apodemes I. Genital shield substantially closer to anal shield than anterior podosternal margin. Adaxial end of apodeme III base latitudinally level with coxite seta *III*, and longitudinally level with coxite seta *IV2*. Custodial ridge present. Discoidal ridge with inconspicuous discidium. No circumpedal ridge. Pedotectum II slim, but long, extending laterally beyond pedotectum I. No midcoxite sculpturing. Lateral coxite setae longer than those around mid-line.

Opisthosternum with genital setae evenly spaced and less than half length of anal setae. No eggs observed.

Legs short (mean femur-tarsus length: 37% of soma). Dorsal porose areas not evident on femurs and trochanters. Rugae posteriorly on femurs III and IV. No ventral keels or flanges on femurs. Solenidium *sol1* on tarsus I fatter than seta *d3*, reaching pretarsal claws. Six ventral setae on tarsus I, proximoventral seta *v2* present, proximal four with 3 or 4 cilia (longest cilium longer than setal base diameter). Pretarsi with three claws (central stout claw, lateral slim claws).

*Male*

As female, except soma smaller, idiosomal length, 177 (2, 175–178).

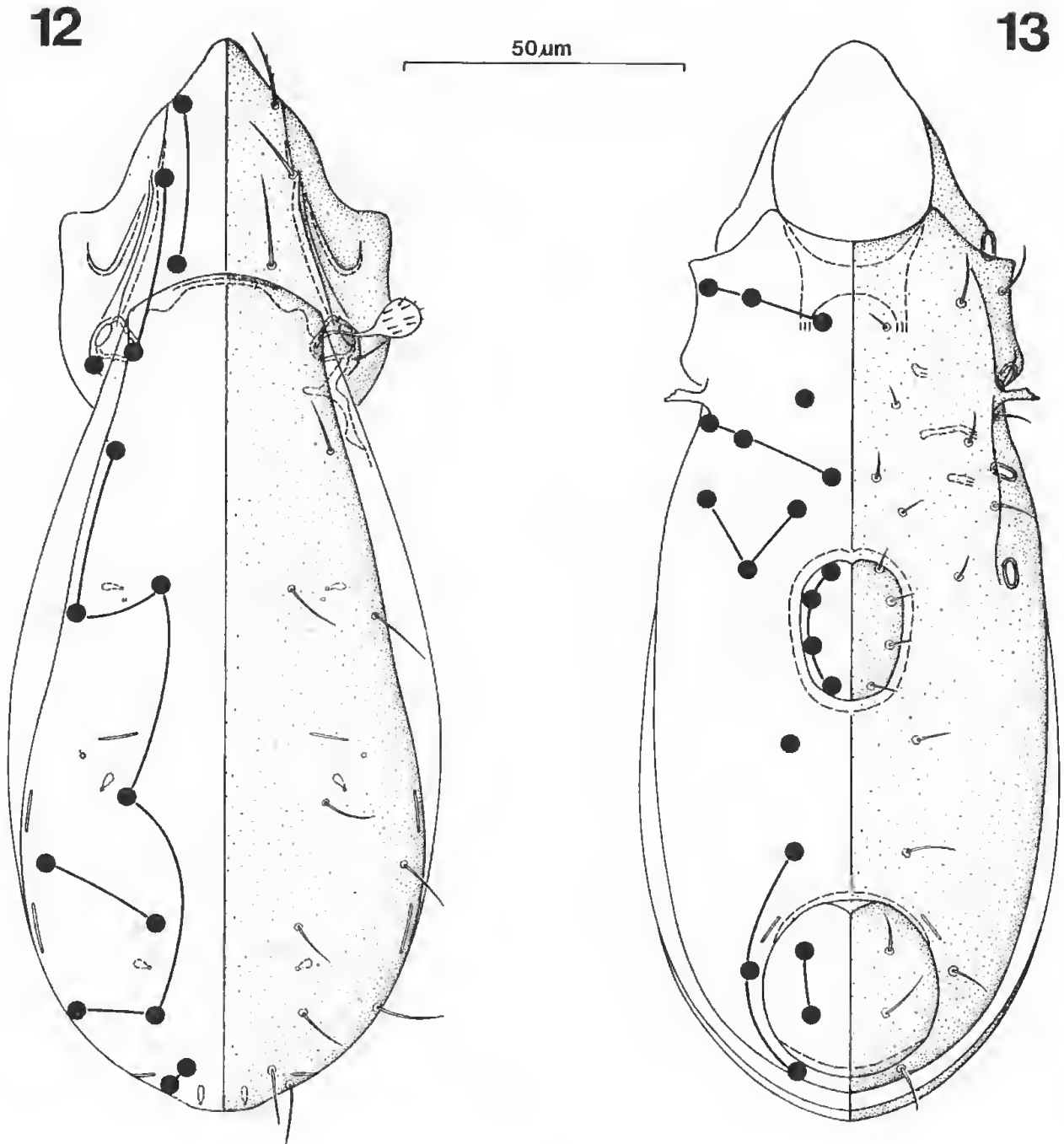
*Material examined*

*Holotype*: ♀ (N1988312); sand, litter, under banksia shrubs (*Banksia ornata*), Tamboore Homestead (35°57'S, 140°29'E), 4.viii.1974.

*Paratypes*: 5 ♀♀ (N1988313–N1988317), 2 ♂♂ (N1988318, N1988319); same data as holotype.

*Distribution*

Australia (Aa), South Australia. Mallee-heath, tall open shrubland (Tamboore Homestead, near Mt Rescue Conservation Park), Murray-Darling basin, 6 ♀♀, 2 ♂♂ / 1 of 8 × 25 cm<sup>2</sup>.



FIGURES 12 AND 13. *Hemileius (Tenuileius) minimus* sp. nov., female soma. 12, notum; 13, idiosternum.

**Remarks**

*H. (Tenuileius) minimus* is the smallest, slimmest species of *Hemileius* so far known. It has a relatively large podosternal region, the shortest legs recorded for *Hemileius*, with short, stout tarsi, and extensive pleural striated cuticle, suggesting adaptation for burrowing, probably in a euedaphic habitat.

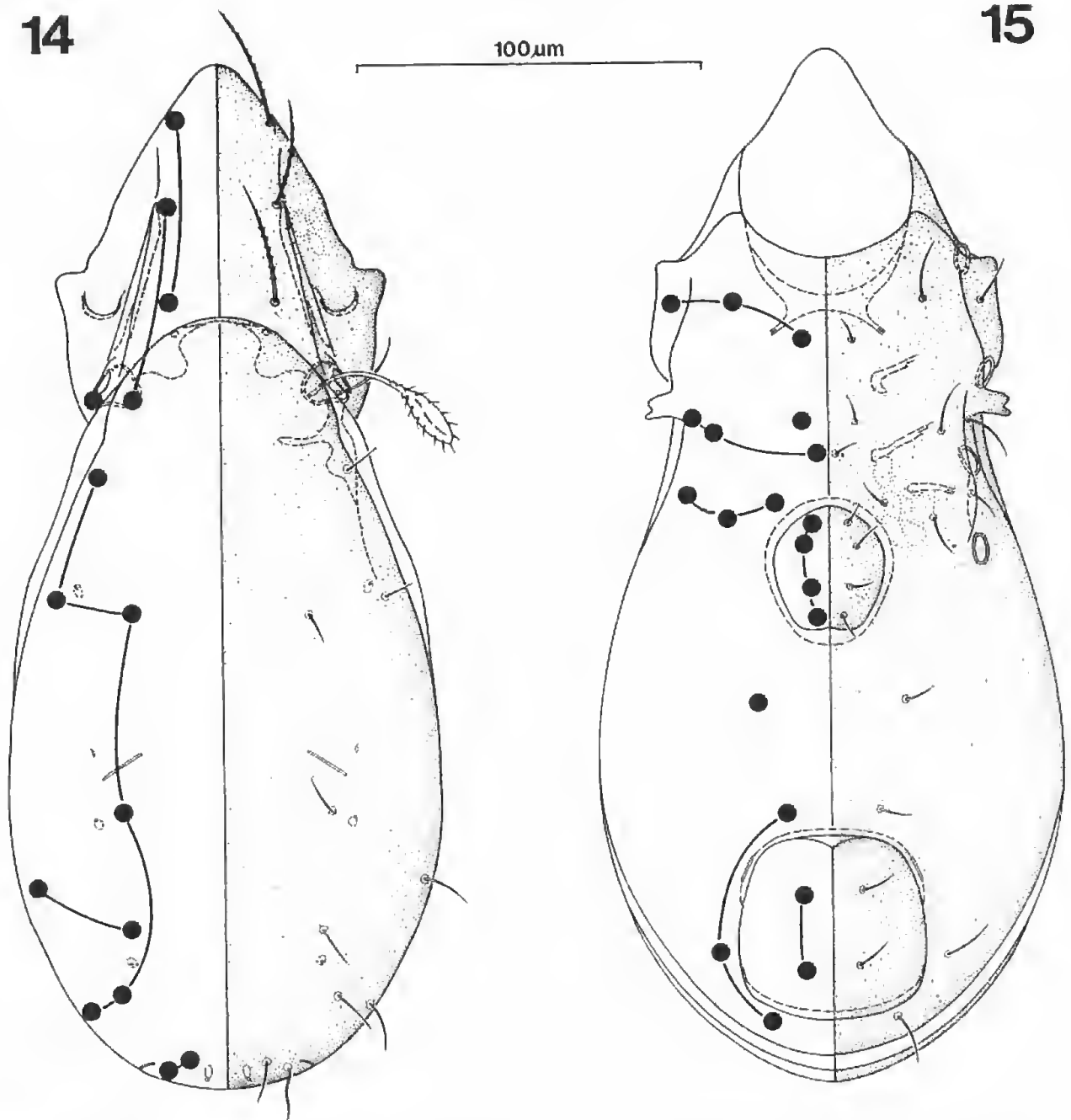
***Hemileius (Tenuileius) paratenuis* sp. nov.**

Figs 11, 14 & 15

**Female**

Dorsal hysteronotal profile oval. Idiosomal length, 296 (3, 293–298). Leg lengths (femur–tarsus for idiosomal length 298): I — 136, II — 108, III





FIGURES 14 AND 15. *Hemileius (Tenuileius) paratenus* sp. nov., female soma. 14, notum; 15, idiosternum.

— 90, IV — 113. Tibial maximum heights (for 298): I — 23, II — 15, III — 12, IV — 14.

Proteronotum either without prelamella or it is incomplete and lineate (Fig. 14). Lamella mainly laminar, linear near  $z_2$ . Sublamella laminar, runs close to lamella along anterior half, bothridium (base of seta  $z_2$ ) close to lamella. Subtutorium present, costate, crescent-shaped. Setae  $j_1$ ,  $j_2$ ,  $z_1$  inconspicuously ciliate, interlamellar ( $j_2$ ) and lamellar ( $z_1$ ) setae medium-length,  $j_2$  reaching beyond level of  $z_1$  and  $z_1$  beyond level of  $j_1$ . Sensory seta ( $z_2$ ) medium length, reaching beyond  $j_2$ ; exposed stalk longer than caput; caput fusiform,

three files of cilia, median file with 7-8 cilia along caput and stalk, anterior and posterior files with 5-7 cilia confined to caput. Seta  $s_2$  length about  $2.5 \times$  diameter of bothridial aperture.

Hysteronotal setae, subequal in length but posterior rank ( $J_6$ ,  $Z_6$ ,  $S_6$ ) longer, sometimes sinuous. Slit-like pore  $hf_3$  oblique, abaxial end posterior; on right side of one female, longitudinal slit-like pore between setae  $Z_2$ - $Z_3$ , presumed  $hf_2$ ;  $hf_4$  and  $hf_5$  near lateral margin, visible laterally (not illustrated); only half of  $hf_6$  visible dorsally (Fig. 14).

Podosternum with moderately wide gap (slightly

less than II-III) between apodemes I. Genital shield closer to anal shield than anterior podosternal margin. Adaxial end of apodeme III base latitudinally level with point between coxite setae III-IV1 and longitudinally level with point midway between coxite setae IV1-IV2. Custodial ridge present. Discidium forms a shallow flap (depth subequal to diameter of setal base IV3). Circumpedal ridge absent. Weak alveolate sculpturing along midcoxite region (Fig. 15, illustrated only on coxite IV). Pedotectum II medium-breadth, long, extending further laterally than pedotectum I.

Opisthosternum with genital setae about two thirds length of anal setae. Genital chaetotaxy very variable, commonest pattern illustrated (Fig. 15), but also 2JZg, 3JZg and 5JZg, missing setae JZg2 and JZg3, extra seta between JZg3-JZg4, confined to one side; spacing varies for 4JZg, usually even, sometimes central space (JZg2-JZg3) extensive so that setae in two groups. No eggs observed.

Legs short (mean femur-tarsus length: 38% of soma). Porose areas on femurs and trochanters III and IV. Indistinct rugae on femurs I and II, distinct rugae on femurs III and IV. Keel with shallow flange on femur II. Solenidium *sol* on tarsus I subequal in diameter to base of seta *d3* and reaching to setae *d4*. Five ventral setae on tarsus I, proximoventral seta *v2* absent, only one (*v3*) ciliate, with six or seven cilia (longest cilium subequal in length to setal base diameter) along two-thirds of length. Pretarsi with three claws (central stout claw, lateral slim claws).

#### Male

As female, except smaller soma, idiosomal length, 273 (5, 262-285).

#### Material examined

Holotype: ♀ (N1988320); soil, litter and sparse grass under coastal wattle (*Acacia sophorae*), Piccaninnie Ponds Conservation Park (38°03'S, 140°57'E), 3.vii.1974.

Paratypes: 2 ♀♀ (N1988321, N1988322), 5 ♂♂ (N1988323-N1988327), same data as holotype.

#### Distribution

Australia (Aa). South Australia. Coastal closed-scrubland (Piccaninnie Ponds Conservation Park), SE coastal, 3 ♀♀, 5 ♂♂ / 2 of 8 × 25 cm<sup>2</sup>.

#### Remarks

*H. (Tenuileius) paratenus* differs from the other two species of *Tenuileius* in having a fusiform sensory seta (*z2*). It is intermediate in size between these species. In details such as the circular pore to the hysteronotal foramina and presence of lateral coxite setae it resembles *H. (T.) minimus*, whilst in its general broader shape it more closely resembles *H. (T.) tenuis*. It is assumed here that *H. (T.) tenuis* has a narrow hysteronotal shield anteriorly, but this is not commented on in its description (Aoki 1982).

#### ACKNOWLEDGMENTS

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#### REFERENCES

- AOKI, J. 1982. New species of oribatid mites from the southern island of Japan. *Bull. Inst. Envir. Sci. Technol. Yokohama Natn. Univ.* 8: 173-188.
- BALOGH, J. 1962. Acari oribates. *Annls Mus. r. Afr. cent. Sér. LXXXV*, 110: 90-131.
- BALOGH, J. & BALOGH, P. 1983. New oribatids (Acari) from the Pacific region. *Acta zool. hung.* 29: 303-325.
- BALOGH, J. & BALOGH, P. 1984. Review of the Oribatuloidea Thor, 1929 (Acari: Oribatei). *Acta zool. hung.* 30: 257-313.
- BERLESE, A. 1908. Elenco di generi e specie nuovi di Acari. *Redia* 5: 1-15.
- BERLESE, A. 1916. Centuria terza di Acari nuovi. *Redia* 12: 289-338.
- BERLESE, A. 1920. Centuria quinta di Acari nuovi. *Redia* 14: 143-195.
- COETZER, A. 1968. New Oribatulidae Thor, 1929 (Oribatei, Acari) from South Africa, new combinations and a key to the genera of the family. *Mems. Inst. Invest. cient. Mocamb., Sér. A*, 9: 15-126.
- DENMARK, H.A. & WOODRING, J.P. 1965. Feeding habits of *Hemiteius* new species (Acari: Cryptostigmata: Oribatulidae) on Florida orchids. *Fla ent.* 48: 9-16.
- EWING, H.E. 1909. New American Oribatoidea. *Jl N.Y. ent. Soc.* 17: 116-136, pls 2-6.
- FITCH, A. 1856. Third (Annual) report on the noxious and other insects of the state of New York. *Trans. N.Y. St. agric. Soc.* 16: 315-490 [not seen].
- GRANDJEAN, F. 1933. Études sur le développement des Oribates. *Bull. Soc. Zool. France* 58: 30-61.

- GRANDJEAN, F. 1951. Sur deux espèces du genre *Domatorina* n.g. et les moeurs de *D. plantivaga* (Berl.). *Bull. Soc. Zool. France* 75: 224-242.
- GRANDJEAN, F. 1953. Sur les genres '*Hemileius*' Berl. et '*Siculobata*' n.g. (Acariens, Oribates). *Mem. Mus. nat. Hist. natur. (n.s.), ser. A. Zool.* 6: 117-138.
- HAMMER, M. 1952. Investigations on the microfauna of northern Canada. Pt 1: Oribatidae, *Acta arct.* 4: 1-108.
- HAMMER, M. 1962. Investigations on the oribatid fauna of the Andes Mountains. III. Chile. *Biol. Skr.* 13(3): 1-37, pls 1-11.
- HIGGINS, H.G. & WOOLLEY, T.A. 1975. New mites from the Yampa Valley (Acarina: Cryptostigmata: Oribatulidae, Passalozetidae). *Gt Basin Nat.* 36: 496-500.
- LEE, D.C. 1987. Introductory study of advanced oribate mites (Acarida: Cryptostigmata: Planofissuræ) and a redescription of the only valid species of *Constrictobates* (Oripodoidea). *Rec. S. Aust. Mus.* 21: 35-42.
- LEE, D.C. & PAJAK, G.A. 1988. *Setobates* (Acarida: Cryptostigmata: Schcloribatidae) from South Australian soils. *Trans. R. Soc. S. Aust.* 112(1): 21-27.
- LEE, D.C. & PAJAK, G.A. (in press). *Schelorbates* Berlese and *Megaschelorbates* gen. nov. from south-eastern Australia, with comments on Schcloribatidae (Acarida: Cryptostigmata: Planofissuræ). *Invert. Tax.*
- MARSHALL, V.G., REEVES, R.M. & NORTON, R.A. 1987. Catalogue of the Oribatida (Acarida) of continental United States and Canada. *Mem. ent. Soc. Canada.* 139: 1-418.
- NORTON, R.A. & PALACIOS-VARGAS, J.C. 1987. A new arboreal Schcloribatidae, with ecological notes on epiphytic oribatid mites of Popocatepetl, Mexico. *Acarologia* 28: 75-89.
- PÉREZ-IÑIGO, C. 1969. Nuevos oribátidos de suelos españoles. *Eos* 44: 377-403.
- PÉREZ-IÑIGO, C. 1984. *Hemileius hierrensis* n. sp. de ácaro oribátido (Acari, Oribatei, Oribatulidae) de la Isla de Hierro (Canarias). *Boletín Asoc. esp. Entom.* 8: 167-173.
- PÉREZ-IÑIGO, E. 1978. Tres nuevas especies de oribátidos de España central (Acari, Oribatei). *Eos* 52: 175-184.
- TRAVÉ, J. 1960. Contribution à l'étude de la faune de la Massane (3<sup>e</sup> note). Oribates (Acariens), 2<sup>e</sup> partie (1). *Vie Milieu* 11: 209-232.